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Analysis of Socio-Economic Factors Affecting Rice Production Systems Among Smallscale Farmers in Luang Prabang Province Laos

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Abstract

This study investigated on socio-economic factors affecting rice production among smallscale farmers in Xiang Nguen District (XND), Luangprabang Province, Laos. Stratified sampling method was employed in determination of the sample size. The primary data were collected for the study through structured questionnaire and data collected from the randomly selected farmers through face to face interviews, resulted in 374 households completed questionnaires. The study used a regression model to determine the relationships between the Economic factors and rice yield as predictor variables. The outcome revealed that the existence of one constraint influenced the other. Land tenure constraints were related to production constraints ($r=0.52$; $p<0.01$) input ($r=0.60$); $p<0.01$). Again, information constraints were related to economic ($r=0.38$; $p<0.01$), input ($r=0.70$; $p<0.01$) and production related constraints ($r=0.62$; $p<0.01$). The yield is inversely related to land acquisition and tenure constraints ($\beta = -0.34$; $p<0.05$). Further, the rice yield in Xieng Nguen was also inversely related to the technological constraints ($\beta = -0.43$; $p<0.01$). Nonetheless, there were positive relationships between farmers' attitude and rice yields innovations ($\beta = 0.22$; $p<0.05$). Moreover, there exist additional opportunities to improve rice productivity through adoption of improved rice cultivars, farm mechanizations, provision of extension services and improved market accessibility.

Keywords: Rice production; Socio-Economic Factors; Smallscale Farmers; Luang Prabang Laos.

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1. Introduction

Laos is a small South-East Asian landlocked country with a population of 6.9 million and a surface area of 236,800 square kilometers, two-thirds of which is mountainous while the remaining third is plains. About 1.8 million of Laos' populace is engaged in shifting cultivation for family subsistence needs and small-scale commerce. Shifting cultivation, however, causes severe environmental and social problems. These geographical and demographic characteristics present both opportunities and challenges for the development of rice production systems in Laos Rice is the staple food in Laos being grown on more than 49% of the cultivated land with annual production of about 3.27 Million tons of paddy mainly for subsistence consumption [1]. More than 51% of rice was produced in central Laos (Savannakhet, Vientiane provinces and Vientiane Capital), about 27% in the southern provinces (Champassak and Saravanh) and 21% in the northern provinces (mainly in Sayaboury) [1]. Per capita consumption of milled rice per annum in Laos is 171 kilograms which constitute almost 70% of calorie and protein intake [2]. As such, achieving self-sufficiency in rice is akin to food security in Laos PDR. Five main types of rice farming systems are practiced in Laos; lowland rain-fed farming, lowland irrigated farming, upland farming, plateau farming and highland farming. No study aimed to quantify losses to rice production caused by rodents in Laos exists, however Schiller and his colleagues 2010 approximated the losses to be more than 15 percent of the total harvest. Rodent damage is more endemic in northern uplands bordering the forest where the regular explosion of rodent populations may lead to about 50 percent or even total crop loss as reported in the wet season of 1991 in some villages in Luang Prabang province [3]. Mice (*Mus spp*.) cause chronic annual damages while rats (*Rattus spp*.) are implicated in periodic losses. Of this problem, most farmers in Laos have the least control, and neither national nor local systems have been developed to combat the rodent problem.Constraints such as dietary preference for rice and the inability to introduce tillage technology on sloping lands in Luang Prabang, however, make it hard to modify livelihood strategies and land-use [4;5]. In addition, agroforestry-based livelihood systems are deeply embedded in the cultural and social life of the many different ethnic communities that steadfastly resist change [5;6]. Development of paddy cultivation is one of the leading areas where public investment has been directed, however, education, health, and transportation have been neglected to the detriment of resource-poor smallholder farmers [6]. The is need to develop robust, sustainable solutions to increase rice production in XND district is apparent to ensure a significant increase in rice production. Establishment of sustainable rice production systems is one such avenue. This development requires the establishment of resource management using local knowledge and introduced ideas to enable farmers to flexibly adapt to changing conditions. Thus, collaborative strategies that involve generation and management of knowledge and risk-management strategies are necessary [8;9;10] suggested that diversification of farming systems, land tenure and human capital formation by the government and multilateral development agencies would successfully enhance livelihood in Luang Prabang. This is in line with numerous past research studies that observed that needs of rural communities in the province are highly differentiated and require locally adapted self-sufficient, diverse, economically viable and small-scale agro-ecosystem based strategies. [8;11;12].

1.1 Statement of the Problem

Despite effort and achievements of the Laos PDR government to ensure self-sufficiency of rice at the national

level, various studies have reported that about 30% of the population has insufficient food for more than six months of the year [13]. Acute food shortages and Chronic malnutrition have been reported to affect up to 47% of the population especially in the Northern and Eastern mountainous regions, while surplus areas are mostly along the Mekong River valleys but poor road networks make distribution painstakingly difficult [14]. According to the second Lao agricultural census conducted in 2010, the number of rice growing households decreased by 6 % between 1999 and 2010. Rice production was also mainly concentrated in seven lowland plains along the Mekong River (Vientiane province, Vientiane capital, Bolikhamxay, Khammouane, Savannakhet, Saravane, and Champassack) where rice biodiversity is low. In the northern highlands where diversity is highest, rice production was rapidly declining accounting for only 19% of national production down by 4% in 2004 [2;5]. As a result, northern provinces and upland areas will continue to experience rice deficits even if national rice surpluses continue to grow [15;16].

1.2 Impacts of dams on upland and lowland agriculture in the Xieng Nguen District

According to Namkhan 3 Hydropower Project final report, 2012. For the purposed of the assessment and presentation the area potentially by the Nam Khan 3 HPP can be divided specification zones, the need for specification the zone differs from topic to topic, with the most detailed specification used for the purpose of social impact planned. The zones used in both the Environmental Impact Assessment(EIA) and the Social Impact Assessment are described in the sections below: The potential affected area from the proposed Nam Khan 3 HPP are located in Xieng Ngeun district, Luang Prabang province, 12 Villags are effected(table 1) with could be divided into 4 impact zones as follows:

- Upstream area: combined of Mokampang village.

- Reservoir area: Kengkoung, Kengkip, Paksa, Thin, Sapheun, Pakbak, Kok, Pakpong, and Khonwai village.

- Construction area: Houysathan village.

- Downstream area: Donmo village of Xiengngeun District, Luangprabang Province

The 12 Village impacted area, therefore, dealing with management on resettlement transformation from 12 villages to a new village (Samakeyxay village in Table 2) were applied management steps by planning, Their agricultural production areas were designated as watershed areas. After resettlement, they have no area of agricultural production, it is has a directly impact on rice production. Sudden changes in rice policies in Laos are frequent and cause significant losses to both millers and farmers. For instance, Lao government policy in 2010 to liberalize the rice industry and allow farmers to export rice outside the country resulted in unexpected rapid exhaustion of rice stock forcing the government to import rice at very high prices [16]. Currently, no sustainable rice production systems that are easy to adopt which will help smallholder farmers exist in XND and hence farmers are unable to produce enough rice for consumption and commercial purposes. The need to develop modern rice farming systems for resource-poor farmers of XND is therefore apparent. So, this study aims to investigated on socio-economic factors affecting rice production among smallscale farmers in XND),

Luangprabang Province, Laos.

Table 1: Land use and forest area (ha) in the affected villages

Village	Total area in the village	Construction Land	Rice land	Swidden Land	Land Plantation	Production Land	Protection Forest	Reservation Forest	Mixed Utilization	Regeneration Forest	Holy Forest	Cemetery
Mokampang	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Kengkoung	1,500	3	-	72	10	336	10	15	10	-	-	0.5
kengkip	1,000	5	-	40	20	189	10	10	7	-	10	3
Paka	1,500	2	4	55	11	170	3	5	3	-	-	2
Thin	2,000	4	-	57	30	70	48	64	47	-	-	2
Sapheun	2,500	5	-	54	35	270	6	20	40	-	1	-
Pakbark	3,000	8	-	400	150	400	15	15	15	-	-	5
Kok	2,000	5	-	74	-	-	20	30	40	-	-	-
Pakong	347	1	-	144	25	144	10	-	10	10	3	1
Houaysathan	1,500	3	-	85	32	-	-	8	-	-	-	-
Khowai	3,000	5	-	23.8	15	30	14	7	4	-	-	-
donmo	2,500	20	30	15	185	100	35	5	13	10	1	0.5
Total	20,847	61	34	996	513	1,709	171	179	189	20	15	13.5

Source: Nam Khan 3 HPP Final EIA Report, 2012. Mark: N/A is non-agriculture

2. Methodology and Research tool

This study deals with the complexity of our subject by using an interdisciplinary approach, combining natural science and social science research methods. Through this interdisciplinary approach, the focus was on the inter-linkages between the different aspects of Rice production in XND, Luang Prabang province. The questionnaire was the primary method used which reflected on our experience, advantages, and disadvantages/shortcomings in the field. A questionnaire is used primarily to get fast quantitative data in the field. We used a standard questionnaire incorporating each assigned subjects to save time and to traverse more households. We used a blend of stratified and random convenience sample technique [17]. Furthermore, the standard questionnaire supports the interdisciplinary approach in terms of benefiting from shared knowledge and inter-linkages between the subjects.

2.1 Study site location and description

The study area was located in upland of northern Laos in Xieng Ngeun District (XND); about 25 kilometers to

the south of the capital of Luang Prabang Province, on the Nam Khan River and Route 13, the main road to Vientiane. Xieng Ngeun District is represented in Figure 1. The study site was selected for this research based on the recommendation of the District Agriculture and Forestry Office (DAFO).

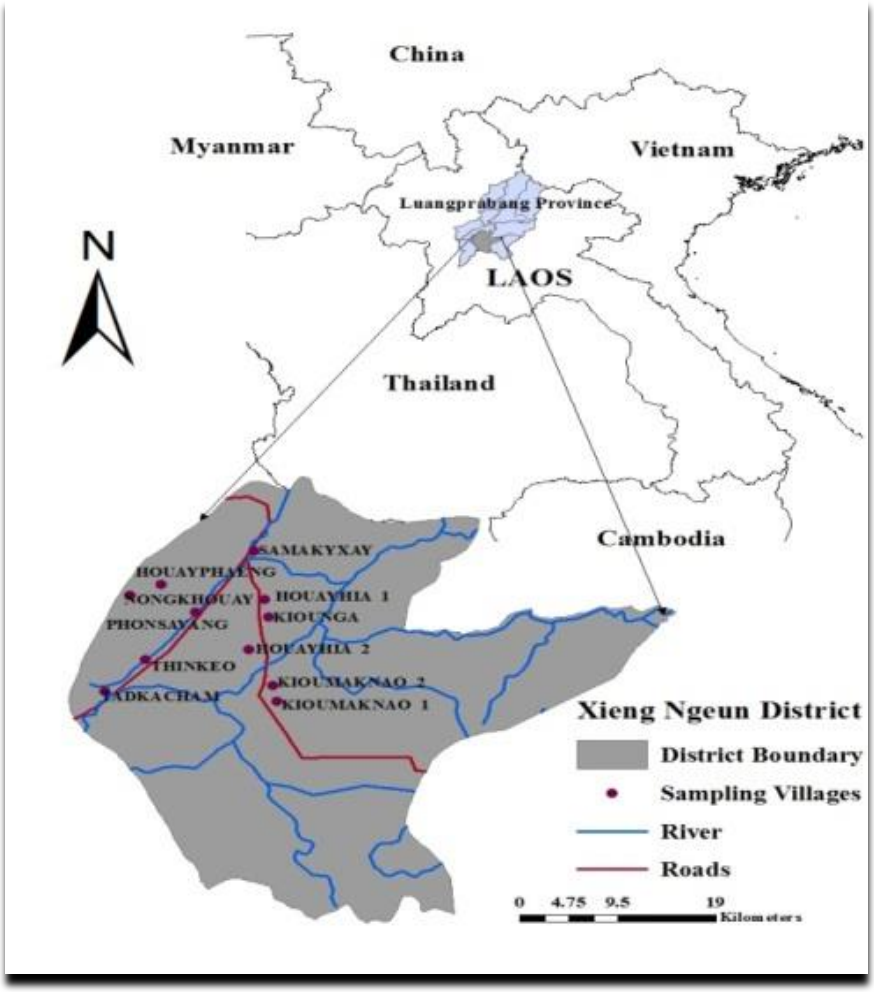

Figure 1: Study site and village sampling located. Source: draw by researcher, 2017

Xieng Ngeun District has 49 villages, 6,600 households, and a population of 33,395 people. Villages included in the survey sample (Table 1) indicate the broad distribution of villages and the location of survey villages in this study. The key informants in this study were headmen, community members, and farmers in the nine (9) selected villages. Questionnaires were administered and the interviews conducted with the current farmers in the study area. A questionnaire, open-ended questions, were floated and same questions asked to individual respondents during the interviews.

2.2 Sampling Method

Various sampling plans such as systematic sampling, simple random sampling, stratified random sampling, cluster sampling, convenience sampling, and purposive sampling were explored. A purposive sample of 374 farmers was selected after the following factors were taken into account: ease of access to the market, the

presence or absence of development projects, ethnicity, and the agro-ecological zone of the village. These factors were hypothesised (from the literature) to be the primary factors affecting the village and its propensity for change and adoption of new technologies. The villages sampled were chosen to reflect these inherently heterogeneous environments. Villages were segregated according to these factors, and then specific villages were selected. This technique maximised the range of villages in the overall sample. The advantage of purposive sampling was the selection of characteristics determined relevant to the research. However, as a non-random sample procedure the bias within the method can lead to sampling errors.

2.3 Data collection approach: Qualitative and Quantitative data

Qualitative methods involving in-depth, semi-structured interviews and open-ended interviews were used to gather data. Observations and field notes complemented the interviews by providing rich description and insights [18]. Written documents were gathered in the form of excerpts, quotations or entire passages from organizational and program records, correspondence, official publications and reports, and open-ended written responses to survey interviews. These significantly contributed to the source of secondary data during the study. In-depth, semi-structured interviews were recorded and categorized for content, meaning, and themes. A quantitative approach was also used to provide a measurable understanding of the farmers' perceptions of their circumstance, livelihood, and lifestyle. Short answer questions, numerical scoring and ranking, and scaled opinions were used in the survey questionnaire as the 'less dominant' quantitative component.

2.4 Analysis of Qualitative and Quantitative Data

The sample size was of 374 farmers; the sample allowed statistical analysis with confidence. Descriptive statistics were used to analyze quantitative data with social science statistical software (SPSS). Descriptive statistics provided a method to describe trends and draw generalizations and conclusions about the farmers using statistically significant results. Both quantitative data and qualitative are reflections of the process that provided the findings. Correlation analysis was used to determine the inter-correlation between the constraints and other study variables. Regression analysis was used to observe the relationships between the yield and constraints as predictor variables as described below:

$$Y = a + \beta X_1 + \beta X_2 + \beta X_3 + \beta X_4 + \beta X_5 + \beta X_6 + \beta X_7 + \beta X_8$$

Where,

Y = Yield

X_1 = Land acquisition and tenure

X_2 = Information and training constraints

X_3 = Attitude and perception constraints

X_4 = Economic market constraints

X_5 = Production and on-farm constraints

X_6 = Technological and scientific constraints

X_7 = Input availability related constraints

X_8 = Total constraints

3. Results and Discussions

The general information of 9 Village in XND, and the most farmers in 9 villages of the study area are residents of rice fields. 1291 households or 74.39% of the household with upland rice and 128 households or 1.86% with paddy rice in table2. So, the determine constraints affecting to rice production systems is importance of famers to improve rice yield in the future, and as developers need, to be involved, to develop the farmers' livelihoods, and food security.

Table 2: Number of farmers with rice planting in 9 village

Village name	NH	SpS	PP	NF	FUR	FUR (%)	FPR	FPR (%)
Kioumaknao	150	57	843	443	80	53.33	-	0
Kiouya	127	33	734	368	127	100.00	-	0
Houayhia	124	43	721	365	114	91.94	-	0
Houayphaeng	49	22	251	119	44	89.80	11	4.38
Nongkouay	48	25	385	184	46	95.83	3	0.78
Tadkacham	223	51	1,379	695	163	73.09	33	2.39
Tinkeo	170	53	966	454	64	37.65	49	5.07
Phonsavang	144	35	785	324	52	36.11	32	4.08
Samakeyxay	655	55	3,419	1,604	601	9		
Total	1690	374	9483	4556	1291	74.39	128	1.86

Source: survey in 2019 by researcher

Mark: NH=Number of Households; SpS = Sampling Site; NF = Number of Females

PP = Population, FUR = Families with Upland rice; FPR = Families with Paddy rice

POFRP = Percentage of Farmers with Rice planting

This study focused on the constraints and opportunities for sustainable development of rice production system in Luang Prabang province in Laos. The study sought to identify the encounters and provides potential mitigation of the problems to enable sustainable rice production in the said area. Over the past year, rice production in Lao

has increased a lot; the country has achieved self-sufficiency of food. Despite the high rice productions in the country, this agricultural sector has had its equal share of opportunities and challenges. Smallholders in Lao PDR face several challenges in farming, especially in rice production. The major obstacles to rice production were lack of agricultural inputs, poor road infrastructure, lack of access to extension services, period drought and crop damages due to insect pests and diseases. To improve upland rice productivity, the irrigation systems must be implemented to assist the rice farmers. The farmers also need to be sensitized to the negative impacts of slash-and-burn systems on the soil fertility. Moreover, emphasis should be sited on the use of fertilizers and pesticides to improve soil fertility and to control rice pests and diseases respectively, in their farms. This call for the improvement of extension services to the farmers through the concerned government departments and ministries. To enhance this, the government need to invest in the development of the road infrastructure. This will not only boost access to the villages but will also enable the farmers to transport farms inputs and produce to and from the farm respectively.

3.1 Rice Production Challenges in Xieng Nguen

The rice constraints in Xieng Nguen rice farms are presented in table 3. The most severe rice constraints were related to the land acquisition and tenure were the poor soil fertility (76.10%), poor road infrastructures connecting the farmers homes to the rice fields and to the market centers (84.1%) as well as the topography of the farming parcels that required high leveling cost (84.1%). Infrastructures such as roads and irrigations play a critical role in improving farm yield as well as the crop productivity. Further, improved transportation is concerned with the better use of inputs, better prices and access to extension services. However, the accessibility, availability, conflict and land fragmentation also affected the rice production in Xieng Nguen. Rice farming requires a secured land on which structures such as bund, canals and dikes could be constructed either permanently or for a considerable period. According to FAO [19,20], land tenure and barriers related to land availability are the significant constraints to agricultural intensification. Further, production and on-farm constraints significantly affected rice production in Xieng Nguen such that water management was 86.1%, and flood 48.9%. Others included drought, weeds, pests and diseases. (1.1%) indicated that improving the natural resource management technology, particularly the improvement of water control systems in the rain-fed lowlands plays a critical role in increasing the rice production among farmers. The primary economic constraints that faced the Xieng Nguen farmers was lack of viable financial agencies to support their rice production (70.50%). Others included poor capital accumulation (70%), and non-availability of loans to help farmers (69.5%). Considerable investment costs reduce the farm productivity. For instance, power tiller seemed a higher investment that not all the farmers could afford. It is a multipurpose hand tractor designed for rotary tilling as well as other farm operations. Therefore, getting access to loans will undoubtedly improve their scale of production. The chief information and training constraints that faced Xieng Nguen rice farmers was lack of access to extension services (45.5%) as well as lack of technical know-how (40.9%), especially water management. As a result, a tested and proved technology that does not reach the intended users is less beneficial. Both the technology innovations, dissemination system and the farmers are required for useful farm production improvement. The farmers should know about the existence of a technology, its benefits, and how to apply the same technique. Further, the external sources of information, such as extension services are essential channels for disseminating new ideas to the farmers.

Table 3: Rice Constraints in Xieng Nguen

Constraints	*Very severe %*	*Severe %*	*Not Severe %*	*Mean*
Land Acquisition and Tenure				
-Accessibility	10.20	31.80	58.00	
-Availability	2.30	14.80	83.00	
-Fertility	76.10	12.50	11.40	
-Affordability	0.00	2.30	97.70	14.61
-Poor infrastructure	87.50	2.30	10.20	
-Topography	84.10	2.30	13.60	
-Land conflict	5.00	15.00	80.00	
-Land fragmentation	13.60	47.70	38.60	
Production and On-farm Constraints				
-Floods	48.90	39.80	11.40	
-Labor	3.40	83.00	13.60	
-Weed	1.10	37.50	61.40	16.53
-Diseases and Pests	0.00	37.50	62.50	
-Water Management	86.10	11.60	2.30	
-Drought	2.30	42.00	55.70	
Marketing and Economic Constraints				
-Lack of Proper market facilities	34.10	36.40	29.50	
-High fluctuation in marketplaces	35.20	30.70	34.10	
-Lack of export marketing areas	29.50	25.00	45.50	
-Gut during harvest	23.90	8.00	68.20	19.92
-Small-scale production	58.00	9.10	33.00	
-Lack of capital	70.00	0.50	29.50	
-Non-availability of loans	69.50	2.50	28.00	
-Lack of finance agencies	70.50	0.00	29.50	
Input				
-Poor varieties of seeds	44.30	46.60	9.10	
-More requirement of fertilizers and manure	54.50	36.40	9.10	
-Unavailability of chemicals for weed and pest control	46.60	43.20	10.20	18.23
-Labor constraints	15.90	34.10	50.00	
-Lack of processing facility	34.10	60.20	5.70	
-Power Tiller	88.60	10.20	1.10	
-High costs of inputs	51.10	45.50	3.40	
Information and Training				
-Lack of information needed	15.90	68.20	15.90	
-Lack of extension and advice on rice technologies	45.50	44.30	10.20	16.85
-Lack of practical farm demonstrations	11.40	12.50	76.10	
-Lack of training on rice technologies	34.10	61.40	4.50	
-Lack of technical knowledge and skill on rice produce	40.90	46.60	12.50	
Technology and Mechanization				
-Non-availability of power tiller	79.50	6.80	13.60	
-Unavailability of technical guidance on power tiller	45.50	25.00	29.50	
-Lack of skills for seed and site selection	73.90	14.80	11.40	27.80
-Lack of knowledge about weed management	55.10	35.20	9.10	
-Power tiller operation for puddling and maintenance	59.10	11.40	29.50	
-Lack of experience and expertise about bunding	33.0	13.60	53.40	
-Dyke construction	13.60	15.90	70.50	
-The complexity of water management	63.60	19.30	17.00	

Source: Researcher's Data in 2019

As a result, the identification and use of appropriate communication channels are substantial. Thus, lack of access to information and extension services hinder farmers from accessing innovative ideas, thus blocking

technical know-how. Moreover, Xieng Nguen farmers were confronted by some technical and mechanical constraints. They included non-availability of power tillers (79.5%) for land preparation activities, lack of skills for land and site selection (73.9%) as well as the complexity of the water management (63.6%). In essence, farmers faced challenges in accessing power tillers for cultivation as well as access to fertilizers during the cropping season. The farmers are again confronted with lack of processing facilities; hence they entirely rely on the locally made drums for threshing rice. Still, power tiller can be used as a source of power for stationary equipment for harvesting and milling.

Farmers' Attitude and Perception of Rice Production

The result of the study indicated that farmers have a positive attitude towards rice farming in Xieng Nguen. As a result of the attitude and perception of the farmers who are the end users of the various activities that make up the rice production package must be put into consideration. Further, perception and attitude are critical for successful research and development strategies and that several promising agricultural policies have failed they have been inappropriate to farmers' need and awareness [21,22]. The agriculturalist's attitude and perception are significantly necessary for successful development plans. Several promising agricultural improvement strategies and policies have failed because of their inappropriateness to the farmers' needs. It must also be observed that the perceived risk of productivity may serve as a barrier to productivity.

Table 4: Farmer's Attitude and Perception of Rice Production

Variables	Agree (%)	Indifferent (%)	Disagree (%)	Mean
Perception of risk	10.20	1.10	88.60	
Perception of low probability	10.20	10.20	79.50	
Non-perception of necessity for sustainability	0.00	26.10	73.90	7.01
Impact of beliefs and traditions	0.00	2.30	97.70	
The negative attitude towards innovative ideas	0.00	14.80	85.20	
Farmers resistant to change	0.00	5.70	94.30	

Correlation Analysis between Study Variables

Remark: LAT: Land acquisition and tenure, POFC: Production and on-farm constraints, EMC: Economic and Market constraints, IARC: Input availability related constraints, ITC: Information and training constraints, TSC: Technological and scientific constraints, APC: Attitude and perception constraints, EL: Educational level, HS: Household size, FS: Farm size. Table 5 illustrates the inter-correlation between constraints to rice production in Xieng Nguen among the farmers. There is a range of constraints that influence the rate of rice productivity innovations. The outcome revealed that the existence of one constraint influenced the other. Land tenure constraints were related to production constraints ($r=0.52$; $p<0.01$) input ($r=0.60$); $p<0.01$) and technical constraints ($r=0.42$; $p<0.01$). It indicated that as the constraints of land tenure persist, farmers are expected to be confronted with constraints related to production, inputs, and technology. Again, information constraints were related to economic ($r=0.38$; $p<0.01$), input ($r=0.70$; $p<0.01$) and production related constraints ($r=0.62$;

p<0.01). It means that information constraints influenced the economic, input and production related constraints of the farmers.

Table 5: Correlation Matrix of the Study

Variables	1	2	3	4	5	6	7	8	9	10	11	12
LAT	1.00											
POFC	0.52**	1.00										
EMC	0.18	0.38**	1.00									
IARC	0.60**	0.7**	0.40**	1.00								
ITC	0.15	0.62**	0.20	0.54**	1.00							
TSC	0.42**	0.02	0.54**	0.61**	0.38**	1.00						
APC	0.01	0.11	0.07	0.10	0.16	0.17	1.00					
Age	0.16	0.09	0.02	0.12	0.11	0.14	0.16	1.00				
EL	0.37**	0.09	-0.29**	-0.41**	-0.25**	-0.39**	0.03	0.51**	1.00			
HS	0.43**	0.09	0.17	0.06	0.25*	0.13	0.04	0.48**	0.13	1.00		
FS	-0.52**	-0.46**	-0.47**	-0.35**	0.14	0.33**	0.13	0.11	0.22*	0.32**	1.00	
Yield	-0.41**	-0.18	-0.45**	-0.22*	-0.12	-0.46**	0.11	0.36**	0.53**	0.34**	0.91**	1.00

Moreover, the size of the farm that farmers possess was negatively related to land acquisition and tenure-related constraints (r=0.52; p<0.01). It means that as much as land tenure problems exist, farmers' farm sizes will

continue to diminish. Furthermore, the land tenure in this study was significantly by inheritance. Using this policy, farmland belonging to the family is shared between all the family members. The distribution continues from generation to generation and with population increment. This also leads to the land fragmentation problems. It as well affects the size of the land available to individual members of the family. The farm size owned by farmers was negatively related to the production and on-farm related constraints ($r=0.46$; $p<0.01$). In essence, due to production constraints, farmers may not be able to expand the scale of their rice productions. Thus, a farmer facing the challenges of offering farm inputs and management of the farm regarding resources for weeding, diseases and pest control, and water control and labor for farm operations might not increase the size of the farm. Again, farm size is negatively related to the economic and marketing constraints. That is, farmers with limited resources such as input, labor, and machine might be constrained thus, not able to increase the size of their plots. It leads to limited rice yields. Nonetheless, household size is positively related to the farm size. It means that as the household increases, the farm size also increases. However, it must be subject to availability of land and other farm inputs. Besides, the relative increase in the household size could serve as a source of farm labor. Moreover, there was a significant negative relationship between input constraints and yields of farmers ($r=0.22$; $p<0.05$). As a result, the non-availability of inputs reduced the farmers' yield. The productivity of rice in Xieng Nguen district depends on the availability of inputs, such as power tillers, fertilizers, improved rice seeds and other farm inputs. Availability of these inputs will influence the level of rice productivity among the farmers in Xieng Nguen. The more available the resources, the greater the level of productivity, and non-availability of these resources pose serious threats to the farmers' productivity. Productivity is hampered by high costs and low availability of farm inputs [20,21]. The unavailability of the appropriate harvest and post-harvest equipment is a significant constraint. Farmers rely on the locally made equipment for harvesting and milling of rice. Several farmers cited access to improved varieties and good quality seed as a significant constraint. Financial constraints have been observed as an essential challenge to the adoption of changed management practices. For instance, the operational and financial constraints are perceived as the significant prime barriers to the approval of natural resources management activities or rather, changed practices. Again, insufficient level of income to invest in new farm practices leads to the inability of the farmers to invest, thus reduced rice productivity.

Regression Analysis Showing the Relationship between Constraints and Yield

The regression model used in this study to determine the relationships between the constraints and rice yield as predictor variables is illustrated in the below equation.

$$Y= 12556.16 – 0.34X_1 – 0.13X_2 + 0.13X_3 + 0.05X_4 – 0.02X_5 – 0.429X_6 + 0.22X_7 -0.27X_8$$

As a result, the yield is inversely related to land acquisition and tenure constraints ($\beta = -0.34$; $p<0.05$). It indicates lack of access to farmland affects the yields negatively. Normally, land fragmentation as a result of the land tenure system limits the availability of land for rice production in Xieng Nguen. For instance, the investment in water supply canals is facilitated by land tenure security. The canals enhance higher rice productivity as water is of importance to the rice growth and wellbeing. Farmers that lack land for production

are likely to spend the allocated input acquisition capital in renting parcels of land. Further, emanating from the interview observations, farmers part with quite a lot of capital when renting farming parcels on an annual basis. Further, the rice yield in Xieng Nguen was also inversely related to the technological constraints (β = -0.43; $p<0.01$). The non-availability of power tillers, unavailability of technical know-how on how to operate the power tillers, lack of skills for the site and seed selection, lack of knowledge and skills about weed management, power tiller operation for puddling and maintenance, and lack of knowledge and skills on bunding, all have detrimental effects on the rice yields of farmers. Nonetheless, there were positive relationships between farmers' attitude and rice yields innovations (β = 0.22; $p<0.05$). It means that farmers' positive attitude towards the new rice farming technologies has a positive effect on the commitment to improve their yield productivity. This will lead to better-improved yields, better water, and weed management qualities in Xieng Nguen rice farms. Moreover, addressing the farmers' rice constraints in Xieng Nguen farms requires a holistic approach where all the limitations identified are observed and addressed to improve the rice productivity in the area.

Table 6: Regression Results of Rice Constraints in Xieng Nguen

Variables	Std Coefficients	t-value	p	Decision (p-value)
Land acquisition and tenure	-0.34	-2.34	0.02	Significant
Production and on-farm constraints	-0.13	-1.06	0.30	Not significant
Economic and Market constraints	0.13	0.94	0.35	Not significant
Input availability related constraint	0.05	0.34	0.74	Not significant
Information and training constraint	-0.02	-0.18	0.86	Not significant
Technical and Scientific constraints	-0.429	-3.597	0.01	Significant
Attitude and perception constraints	0.22	1.68	0.05	Significant

Source: Researcher's Field Data in 2019

4. Discussion and Conclusion

This study focused on the constraints and opportunities for sustainable development of rice production system in Luang Prabang province in Laos. The study sought to identify the challenges and provides potential mitigation of the problems to enable sustainable rice production in the said area. Over the past year, rice production in Lao has increased a lot, self-sufficiency of food has been achieved by the country. Despite the high rice productions in the country, this agricultural sector has had its equal share of opportunities and challenges. A sample size of 374 respondents took part in the survey from the XND study area. The Pearson Chi-Square had a positive value, p = 1.68, with a likelihood ratio of LR = 1.8. The Spearman Correlation was significant with a value of SC = 0.067. Therefore, not assuming the null hypothesis and concluding that the variables are not correlated. About 15 farmers owned either a car/truck or a hand tractor. The tractors could be used in transportation and ploughing different parcels of lands. Therefore, it is justifying the previous assertions from the descriptive analysis that some of the farmers engage in large-scale farming techniques. The variables were significant based on the standard approximations of both the Pearson's R and Spearman correlation. Farmers across the globe are faced with farming uncertainties as a result of lack of agricultural information. Such information relates to farming

inputs, pest controls, ploughing periods, as well as harvesting techniques. Differences in accessing various agricultural farming information are the reasons that have resulted in different crop productivity yields. However, the lack of response when the farmers were asked whether they get help from the government could be interpreted as lack of extension services, either because of the poor accessibility of the areas for any other reason (s) that was/were not captured during the study. It was evident also from the findings that 12% of the respondent farmers had alternative sources of earning apart from rice production. Another 7% were either employed in temporary measures by the government or the public services or in the nearby farms. However, among the other agricultural products, the turnover from the sale of livestock was significant when cross-tabulated with the turnover from banana, job's tears, and maize. It indicated that livestock production offers a healthy competition to the rice market and production. However, a higher percentage of the respondents stated that they had no access to the clean and fresh water in the determining the coefficient percentage because it was a string variable 98% agreed that water availability was a challenge. It is dominating the challenges to the rice farming as the worker's health at risks.

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